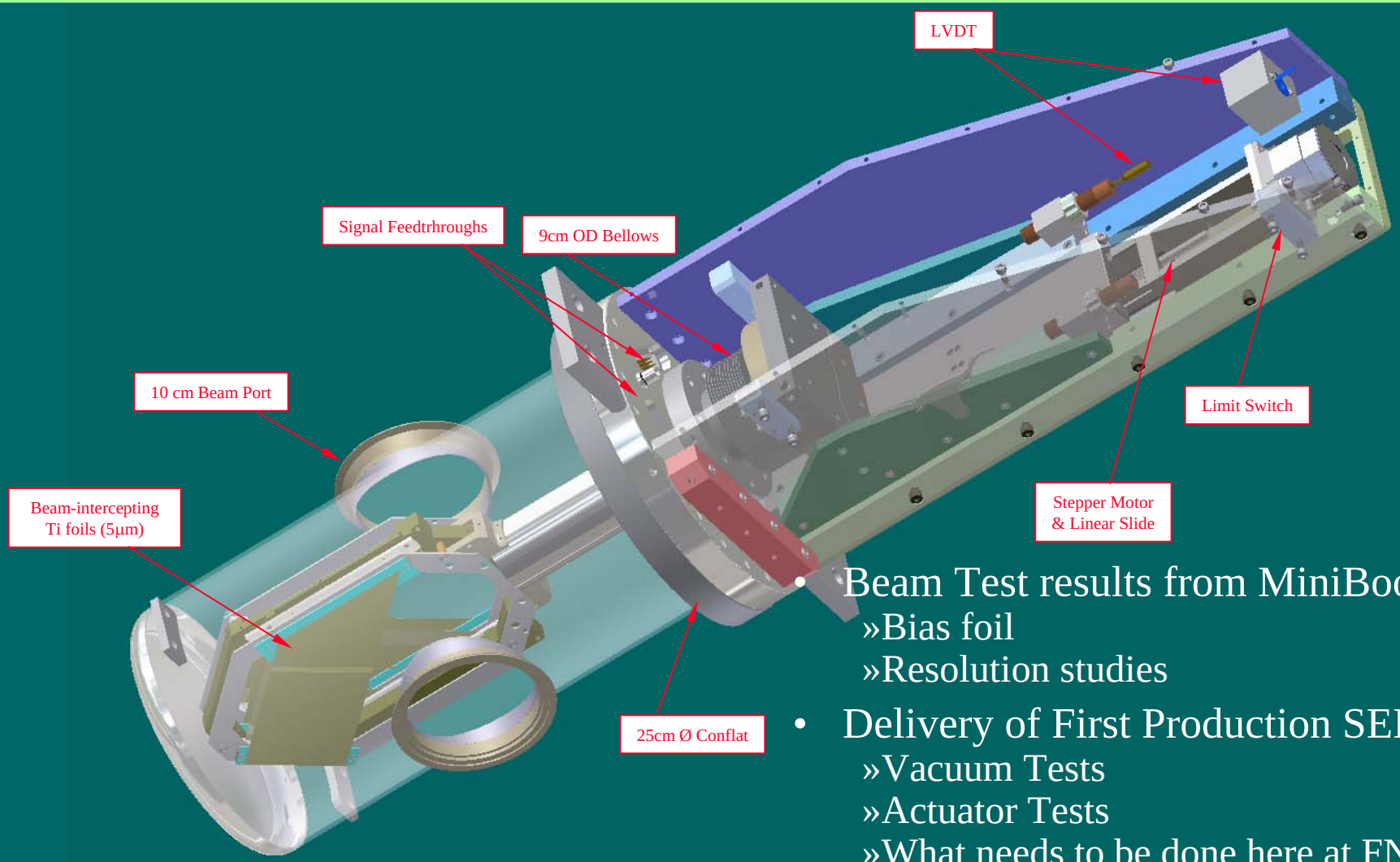
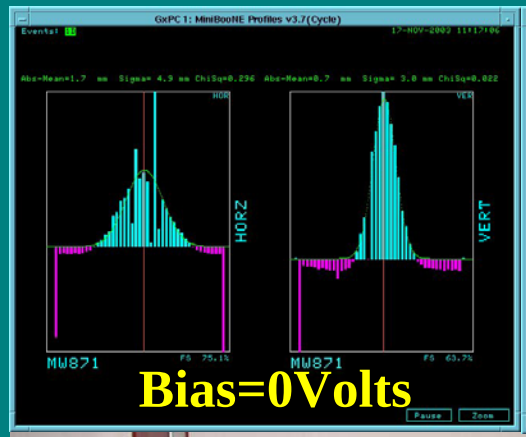
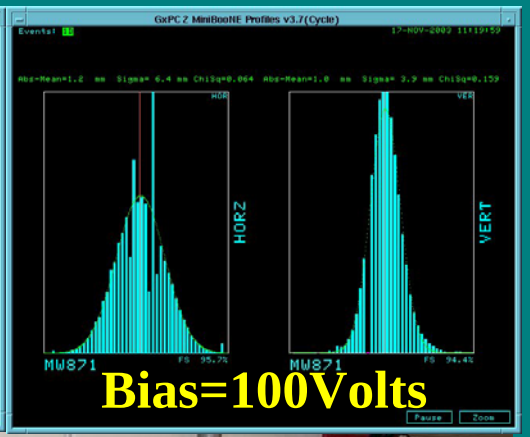
Progress on Profile Monitor SEM's

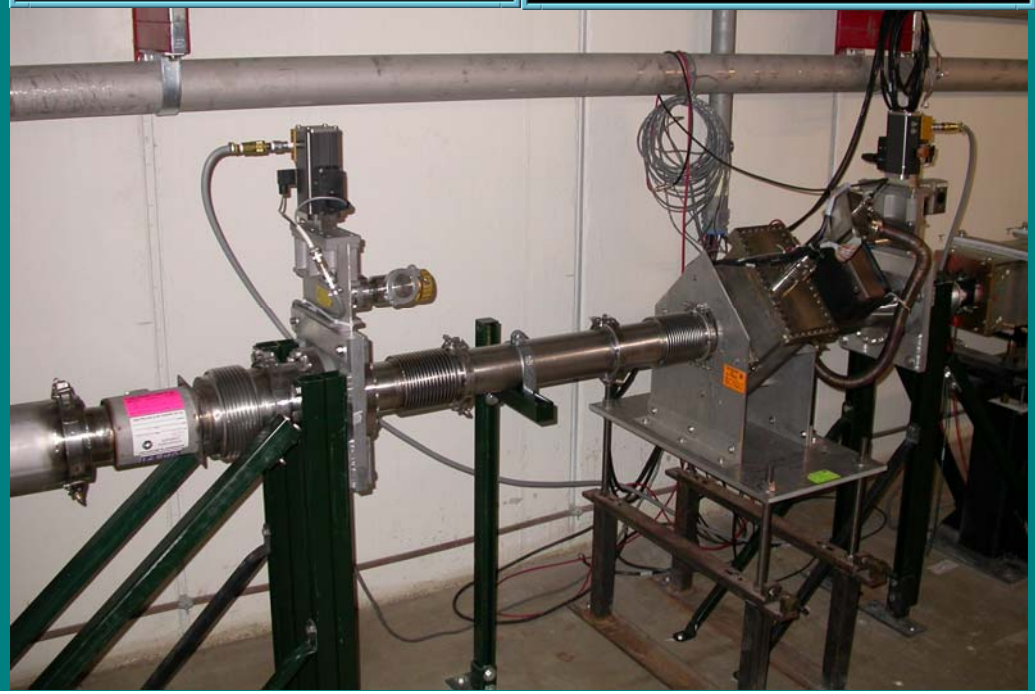


- Beam Test results from MiniBoone
  - »Bias foil
  - »Resolution studies
- Delivery of First Production SEM
  - »Vacuum Tests
  - »Actuator Tests
  - »What needs to be done here at FNAL
- Production Outlook

Beam Test in MiniBoone Transfer Line

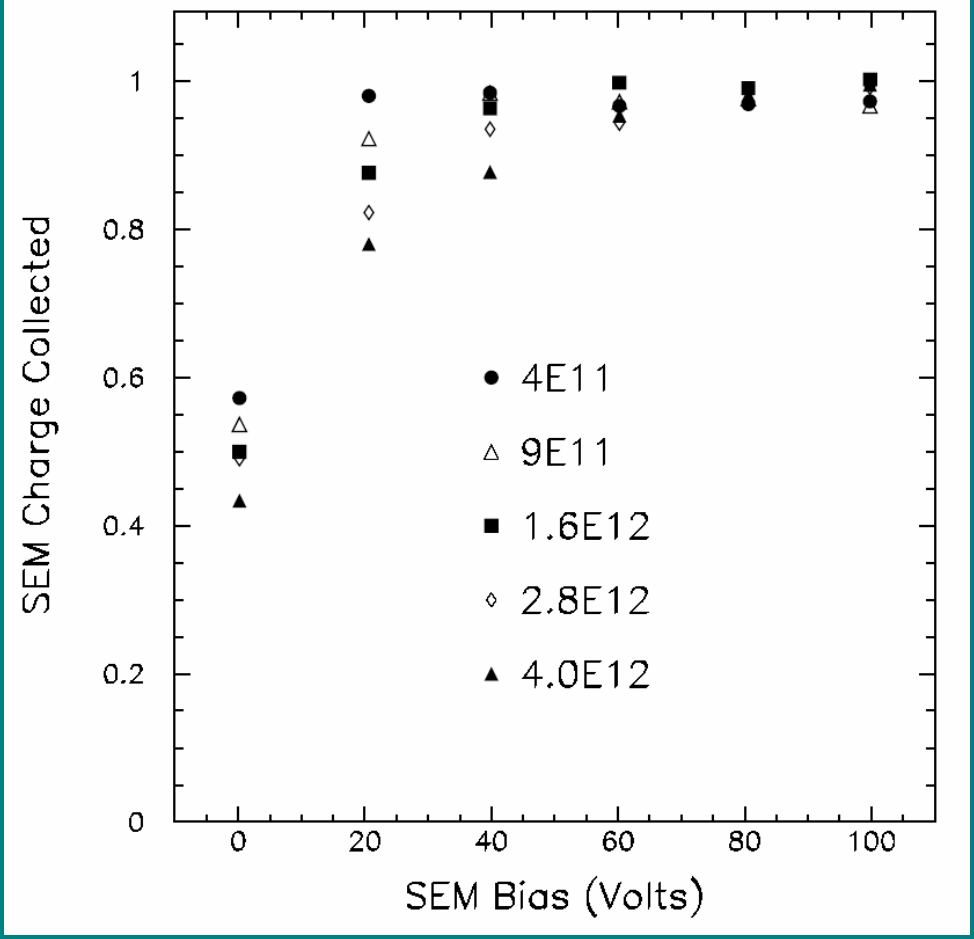






- Two study periods:
  - »Fall ’03 long term data collection during normal MiniBoone running
  - »March ’04 repeated bias foil study

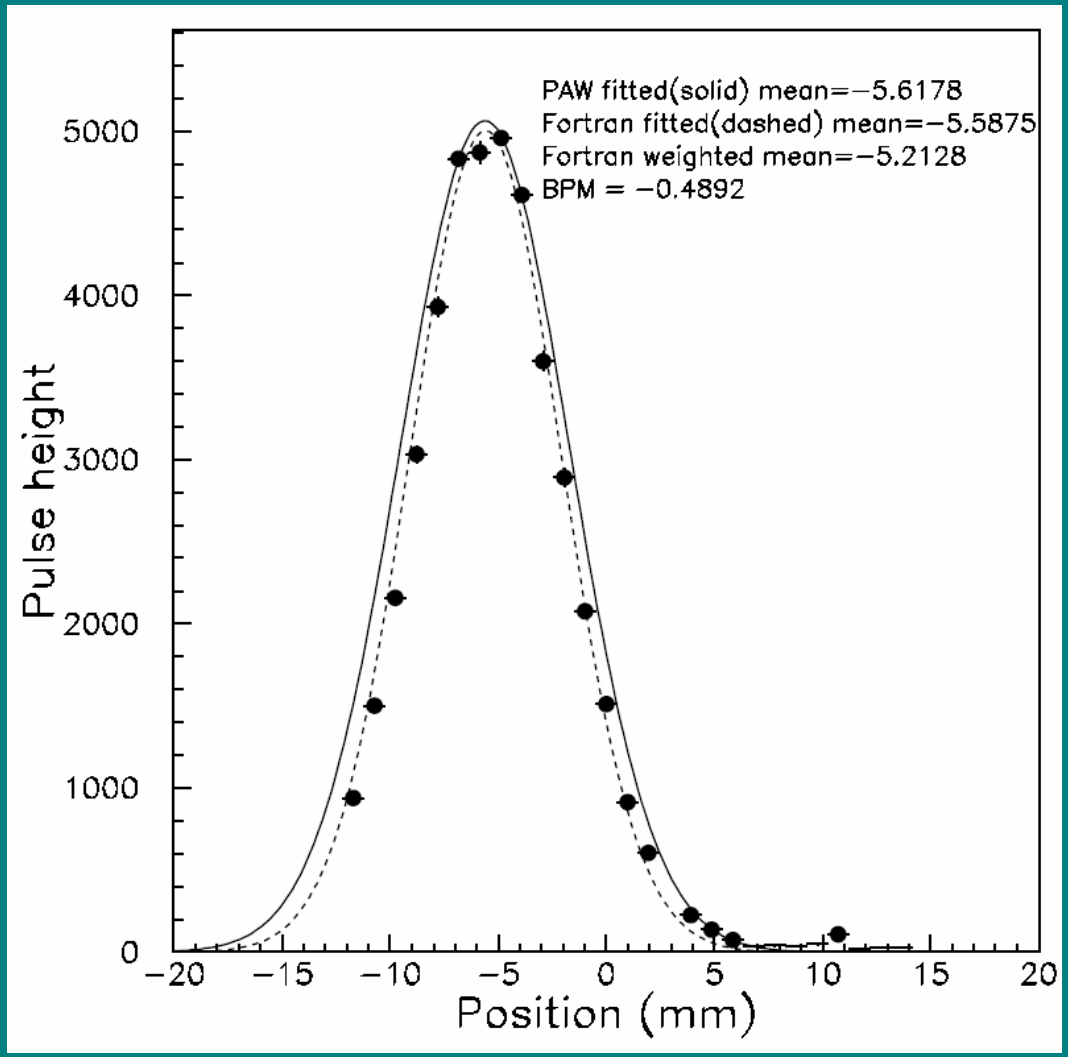
Bias Foil Data



- Repeat study at several beam intensities
- Each point is a single shot, so fluctuations possible
- Vertical scale is pulse height on all SEM strips divided by Toroid intensity (normalize to 1.0 at 100V and lowest intensity)
- Reasonably good evidence for utility of the bias foil.

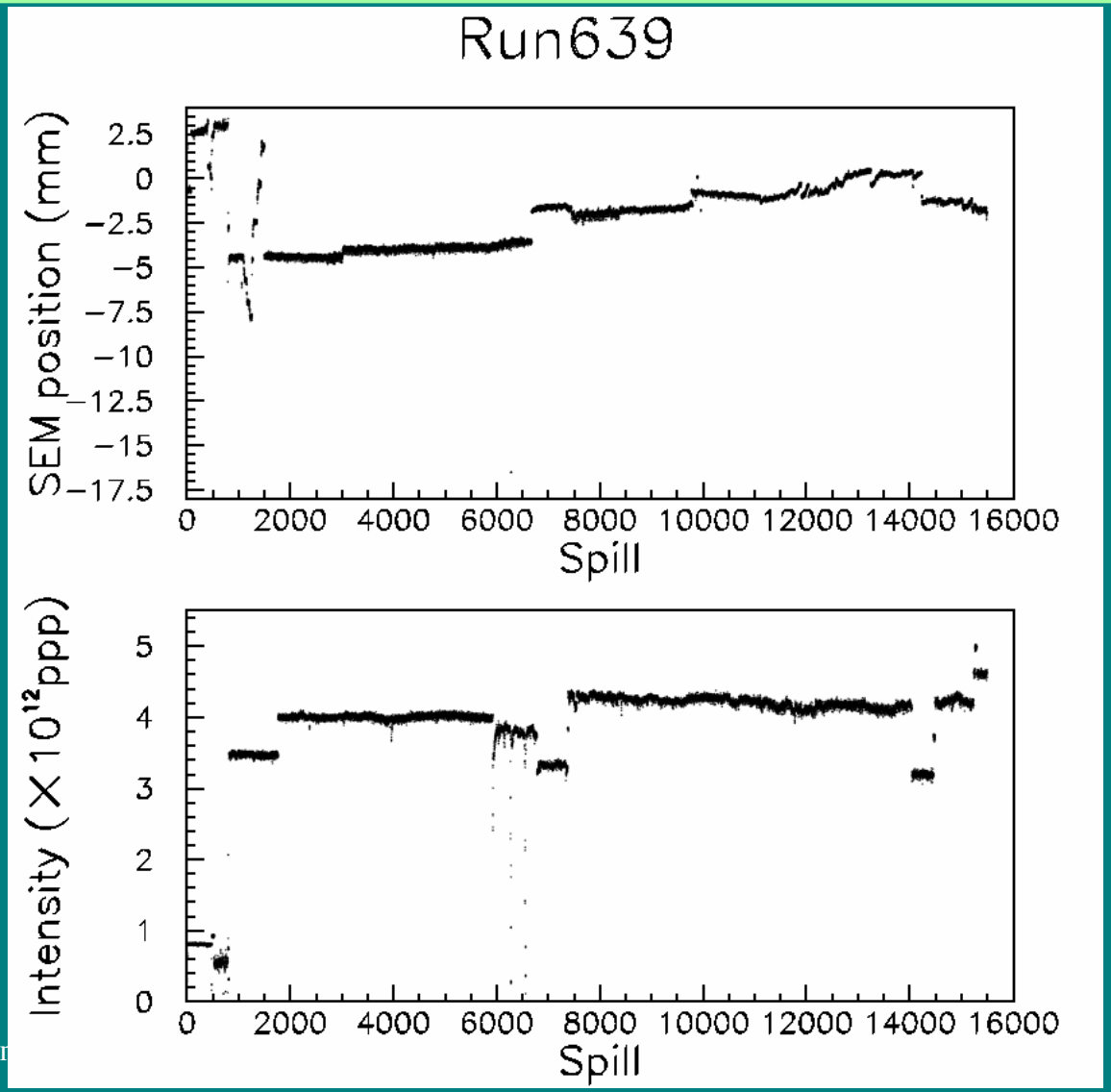
Resolution Studies

- Over 50K spills from last Fall
- Could study resolution one of two ways:
  - »Hope beam stable at one position, measure deviation of reported position from SEM
  - »Allow spills where beam is moving around, try to correllate with BPM nearby (VP871)
- Two quantities to estimate centroid from SEM
  - »Pulse-height weighted mean strip number
  - »Fitted mean strip using assumed gaussian profile of beam.

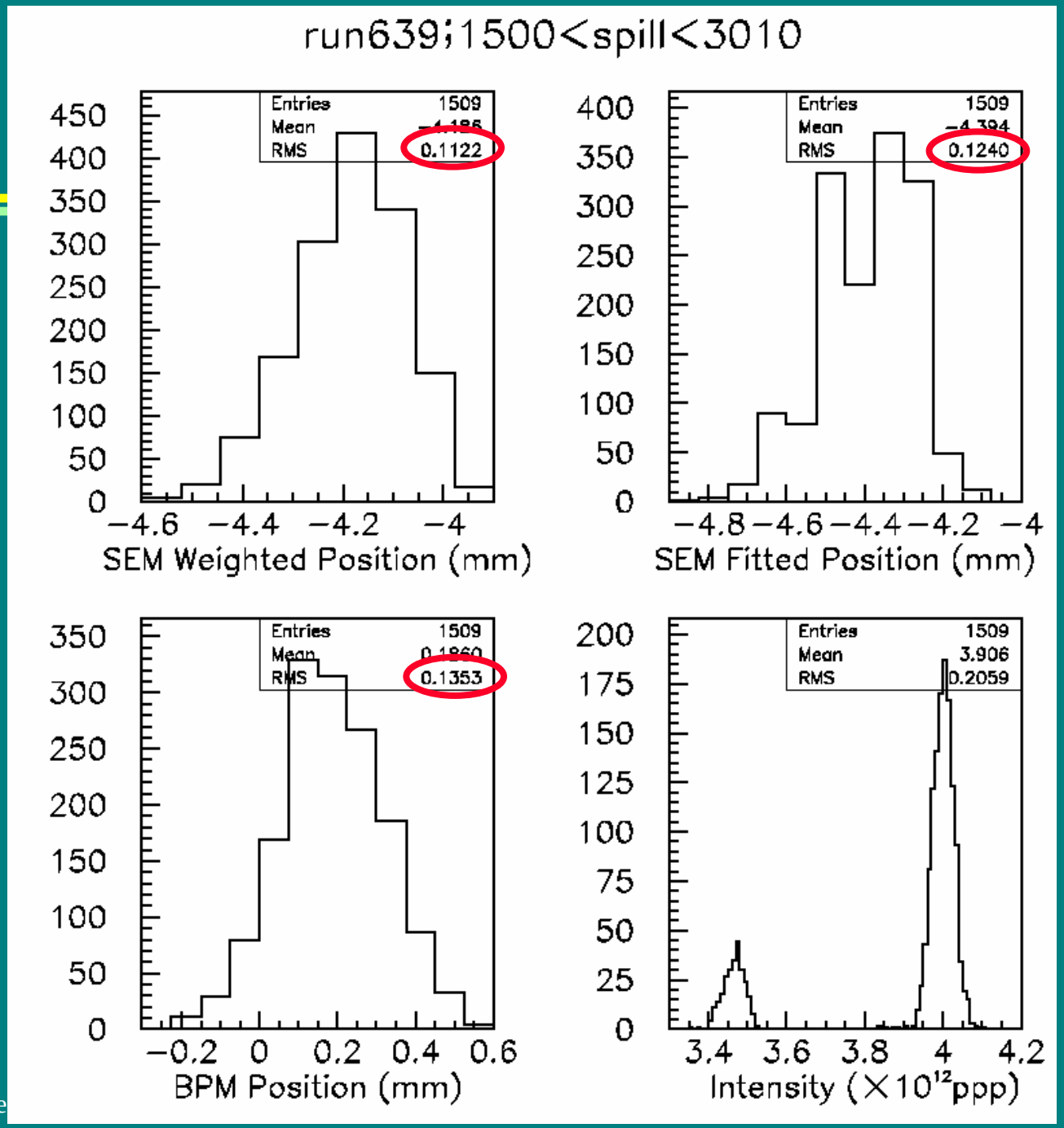


An Example of Looking for Stable Beam

- Run numbers correspond to MB-supplied runs
- Look visually at this plot, take projections over several spill ranges
- Approximately 5 such runs we looked at

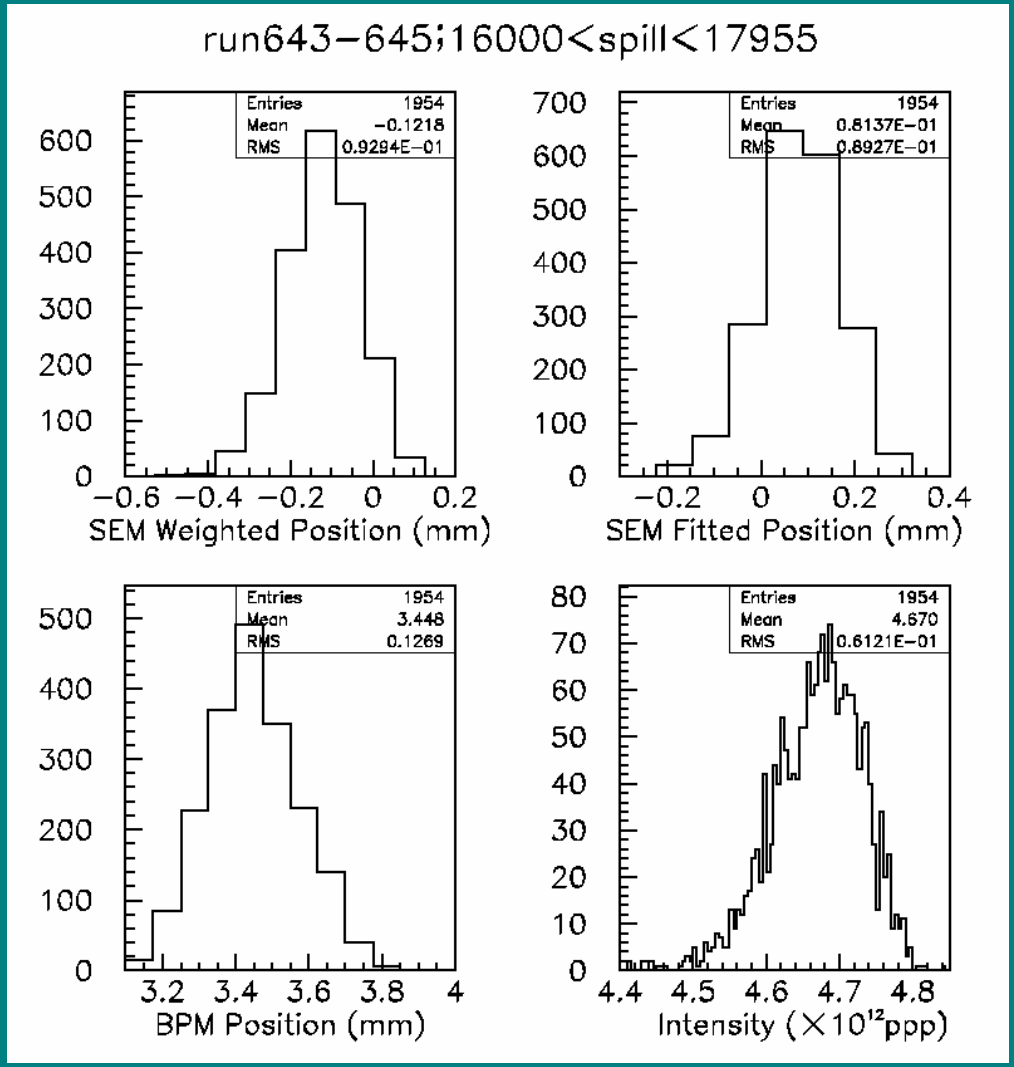


- Generally observe fitted SEM position worse spread than weighted mean
- Generally SEM is smaller spread than BPM



But is Beam Ever Truly Stable?

- Over some spill ranges spread is more like 150μm, others (here) closer to 90μm
- Does variation come from
  - »Beam moving over course of our projection
  - »Intensity?
  - »Comparing spreads when beam hits different location on our SEM (recall strips probably not perfect!)

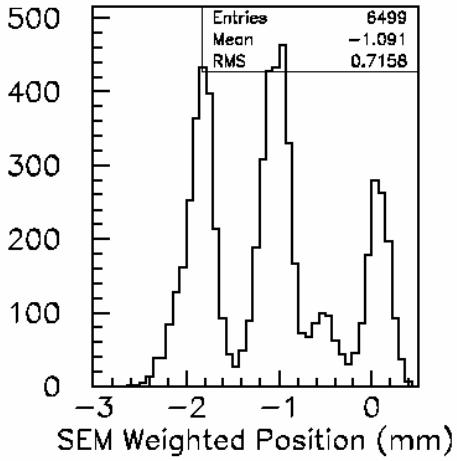


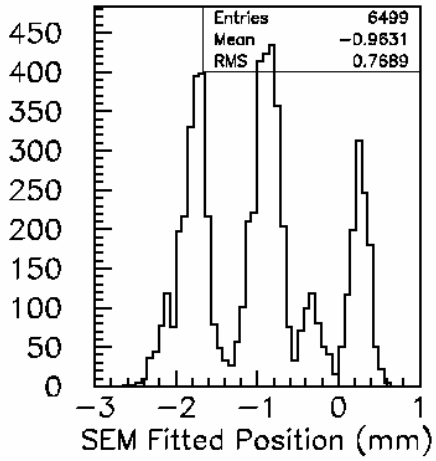
Comparison of Several Periods

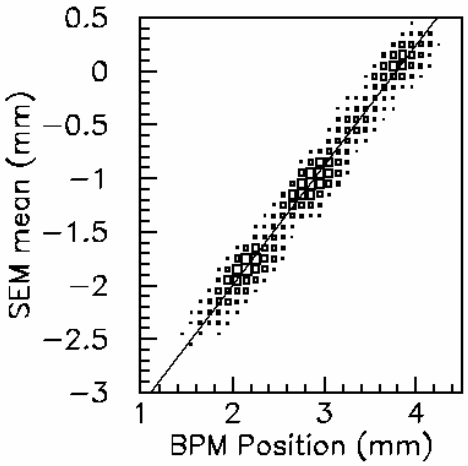
Best guess if presume beam movement is culprit

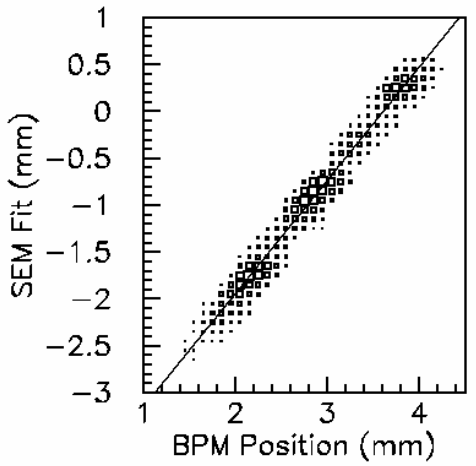
Run/spill	Weighted SEM pos. Spread (μm)	Fitted SEM pos. Spread (μm)	Vertical Position on SEM (mm)	BPM spread (μm)	Beam Intensity (10^{12} ppp)
643/ 16000-18000	93	89	-0.12	127	4.7
643/ 10000-15000	145	147	-0.6	158	4.6
643 / 2200-5500	158	180	-4.5	189	4.6
641 / 16300 – 18100	111	131	-4.8	137	4.7
641 / 12800 – 14300	136	146	-2.4	162	3.9
641 / 7000 – 8700	154	155	-0.5	158	4.6
640 / 5600 – 7000	136	141	-1.0	150	4.6
640 / 4200 - 5600	126	134	-1.5	143	4.6
640 / 1000 - 2900	131	142	-1.3	150	4.6
639 / 1500 - 3000	112	124	-4.2	135	3.9

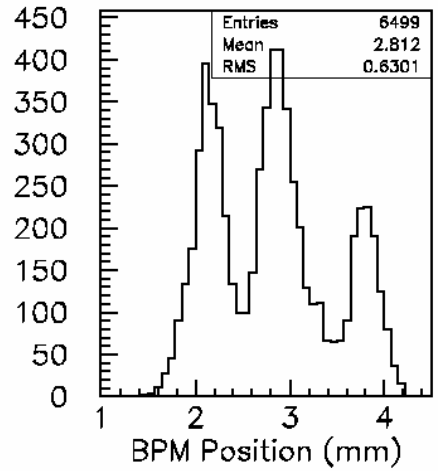
Correlate with BPM?



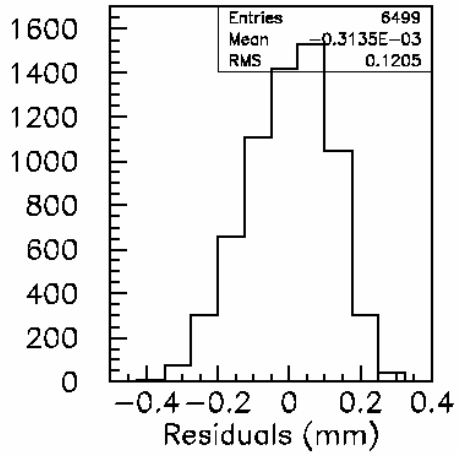


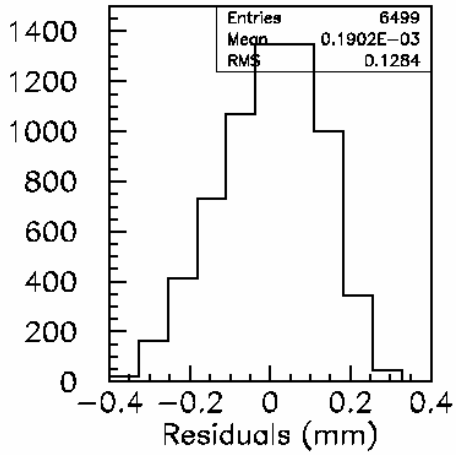






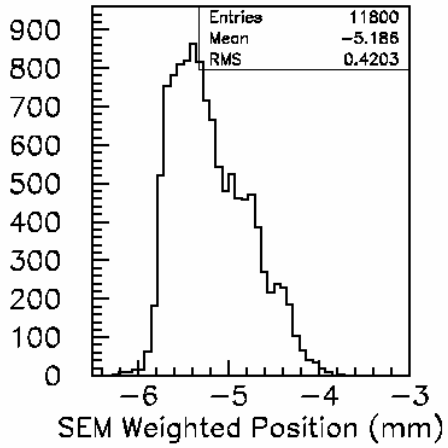
- Impression is that SEM resolution smaller than BPM?
- Residuals fold in BPM+SEM resolutions
- If assume *equal* SEM, BPM resolutions then SEM ~ 85 μm.

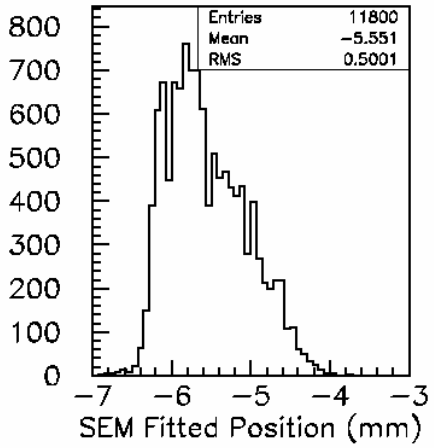


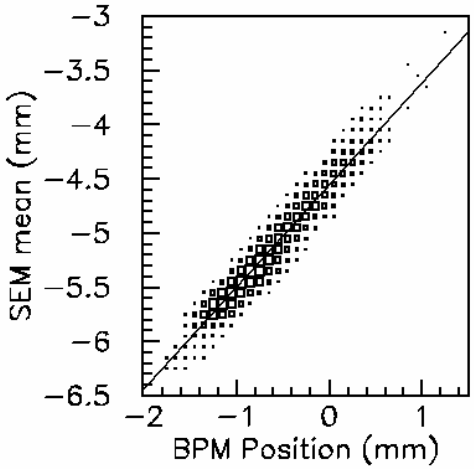


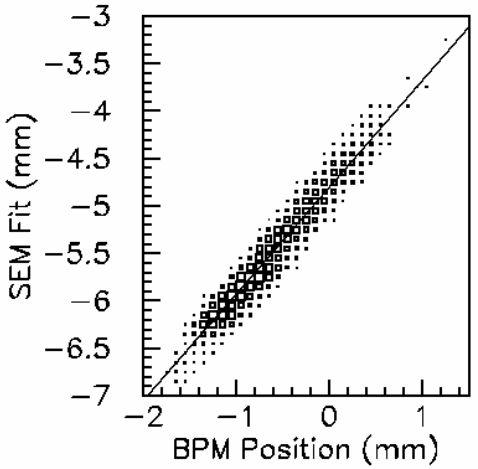
Run 639, spills 7500 – 14000

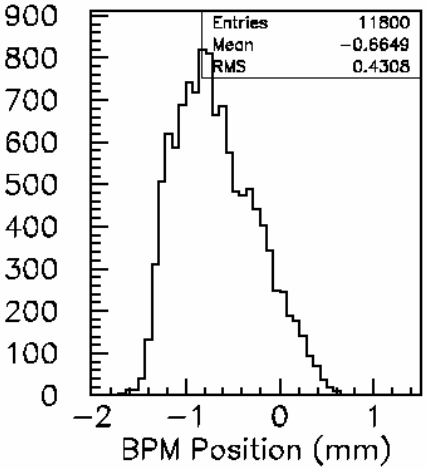
Another Time Period to Correlate with BPM



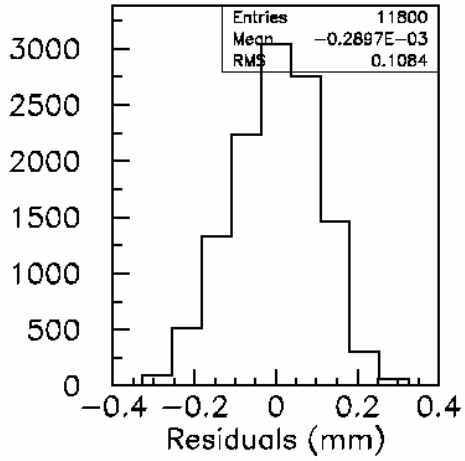


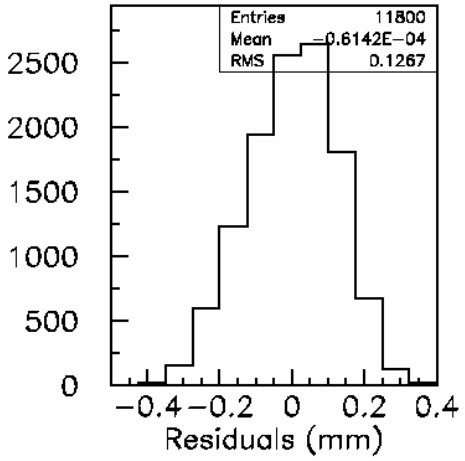




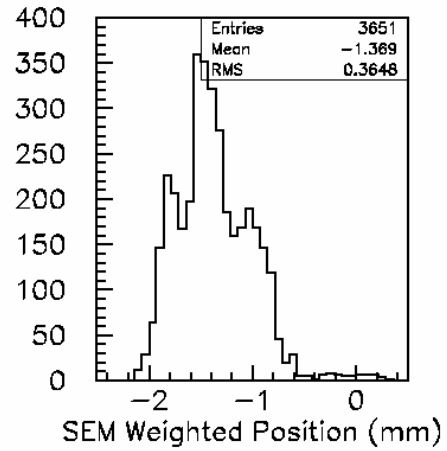


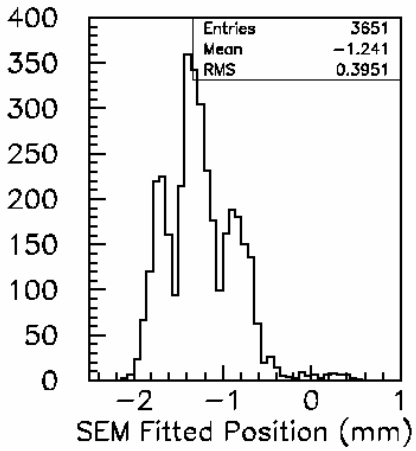
- Similar (maybe a little better?) results
- Different location on SEM
- Similar spread of beam over SEM (3mm)

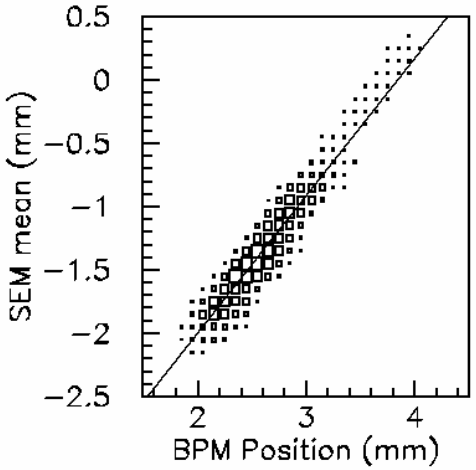


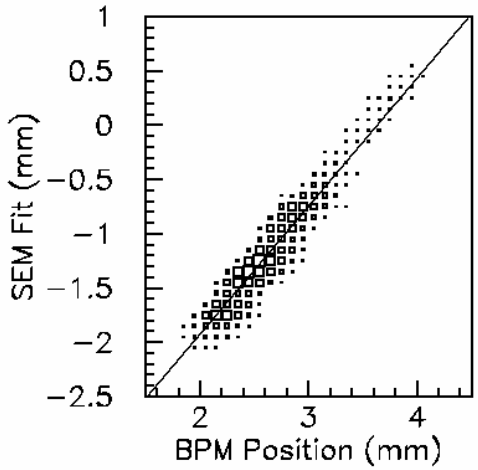


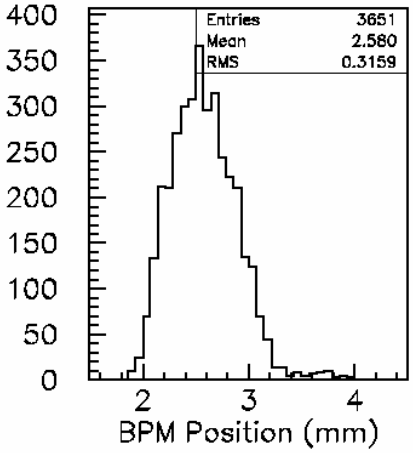
Run 642, spills 0 – 11800



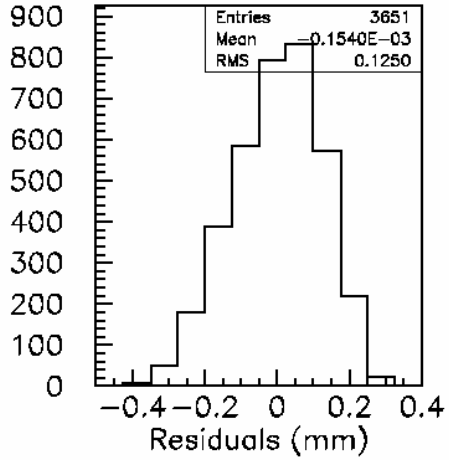


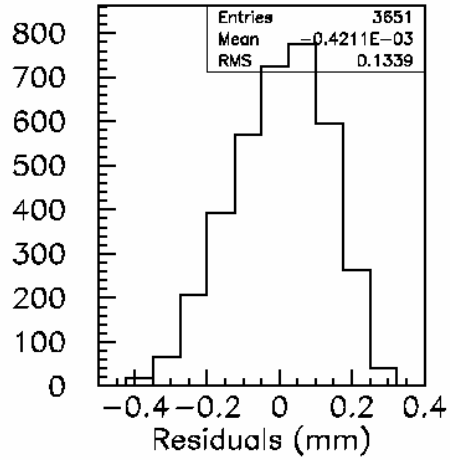






- Still lingering impression that SEM, BPM, σ's are not equal



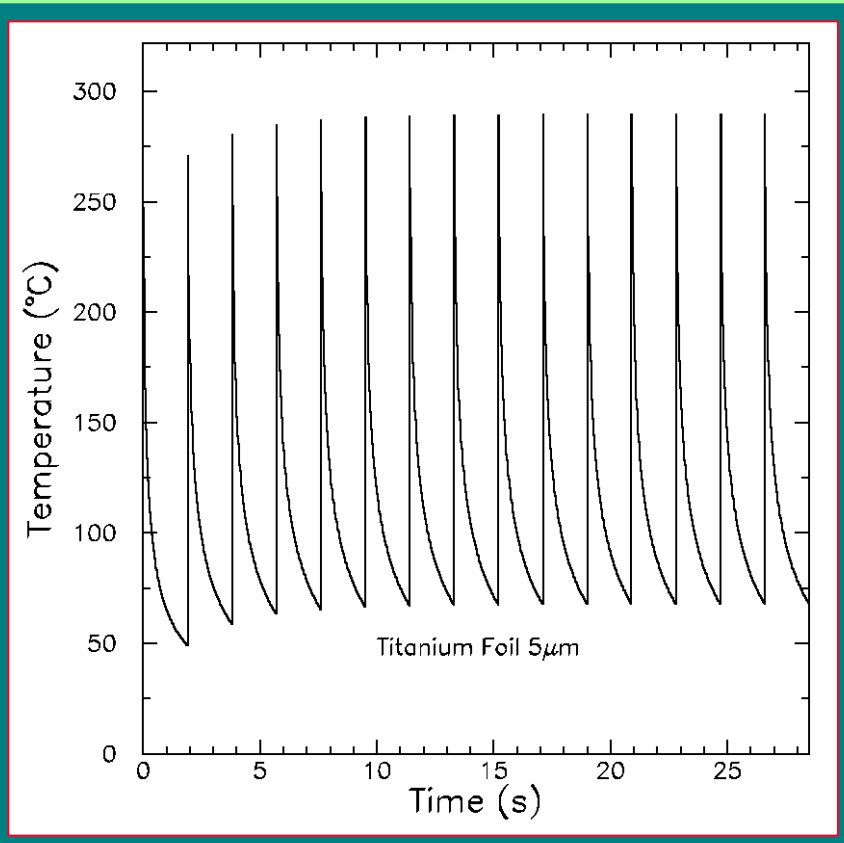


Run 640, spills 11900 – 16000

Thermal Simulations

- Input *dE/dx* for 120GeV protons (restricted *E* loss $dE/dx[T_e<T_{cut}]$)
- Cooling assumes blackbody radiation, thermal cond. to ends of foil/wire

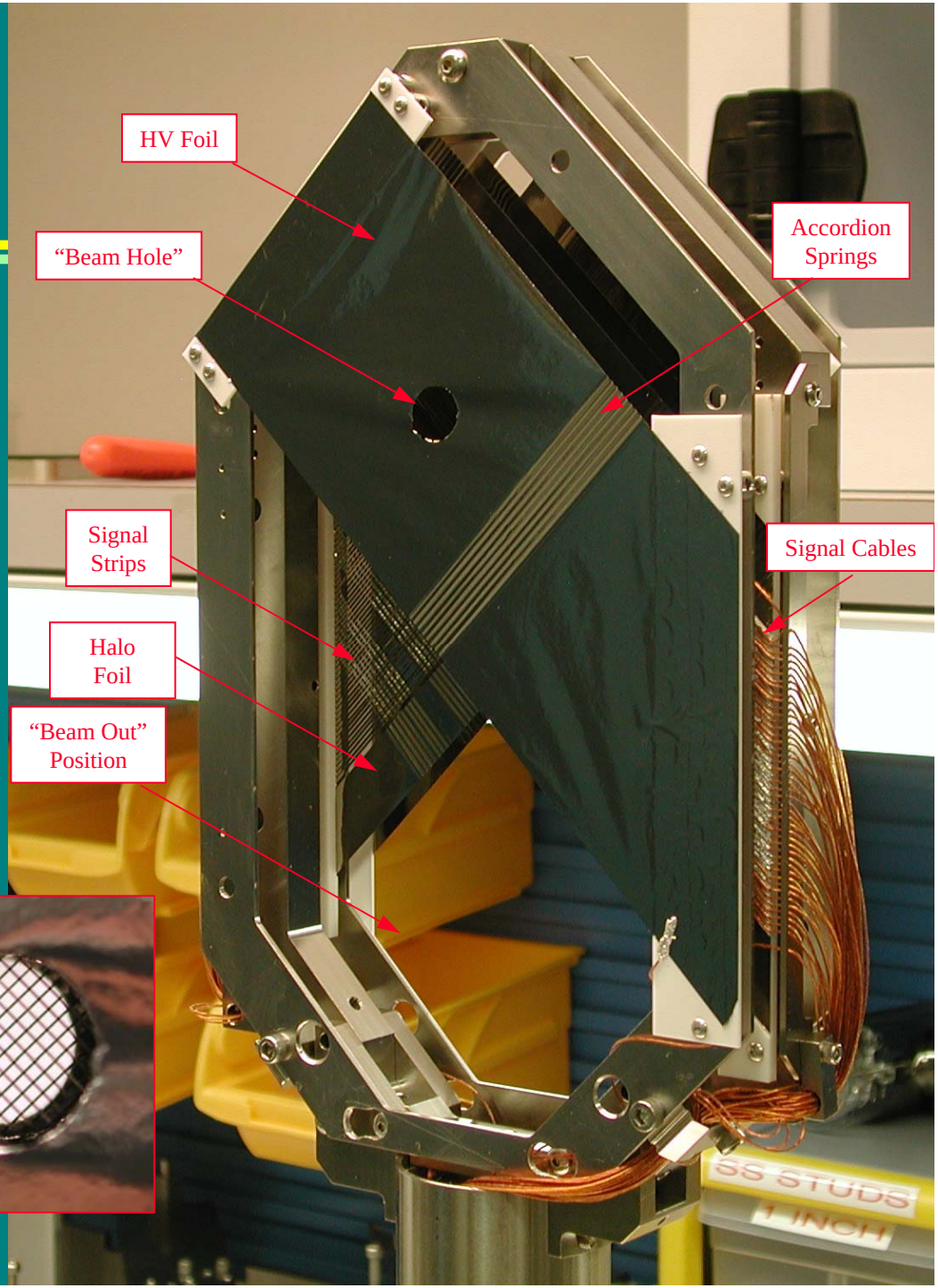
Material	ΔT (°C) (5μm foil)	Fractional Elongation ($\times 10^{-4}$) (5μm foil)	Dynamic Stress (MPa) (5μm foil)	Yield Strength (Mpa)
Be	64	0.92	188	240
C	186	0.25	19	469
Al	138	2.9	238	35
Ti	222	1.1	208	220
Ni	264	4.6	736	1580
Ag	449	5.4	709	
W	715	2.5	1305	550
Au	729	7.1	807	205



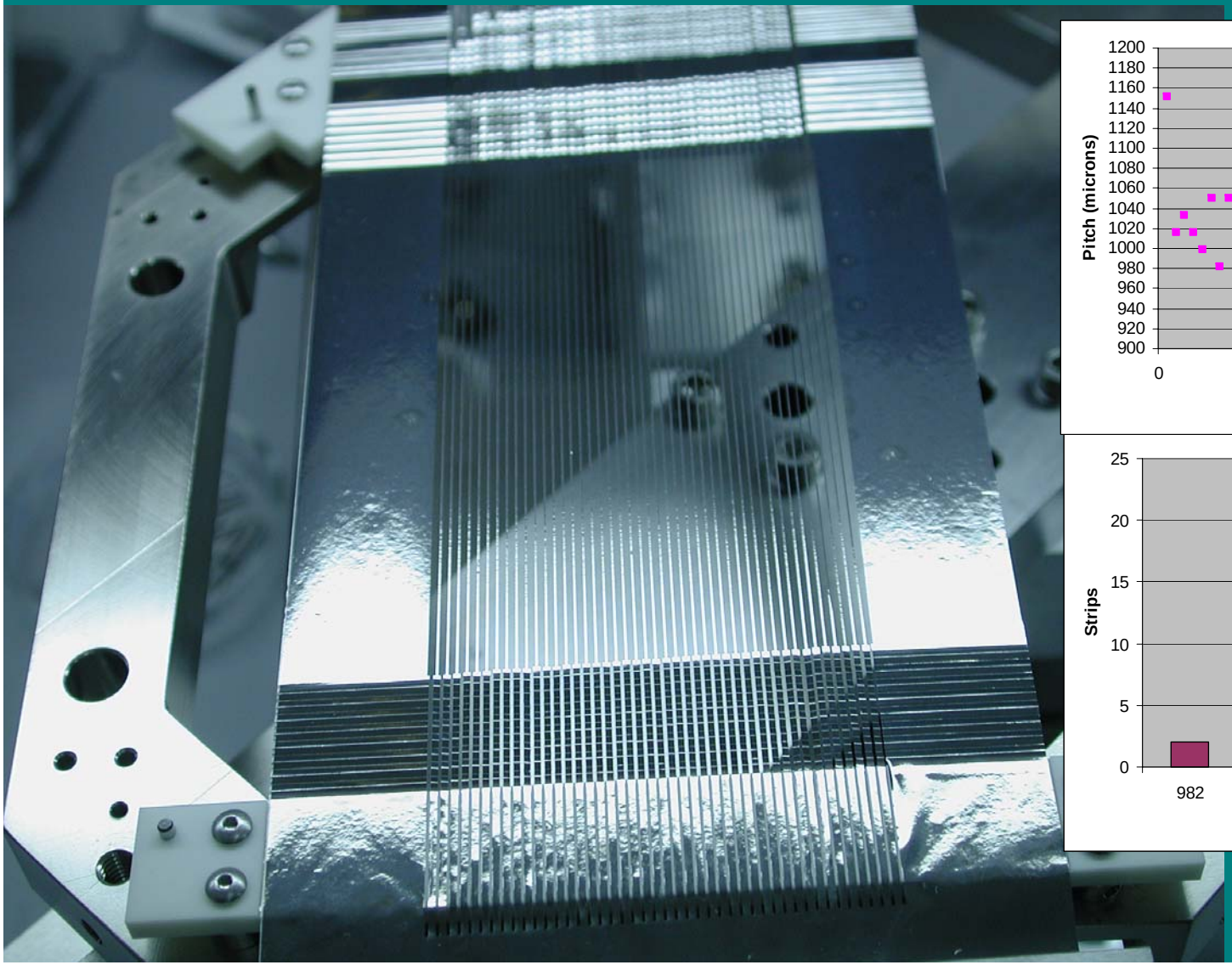
- Thin foil strip heats less than wire
  - Larger surface/volume ratio
  - More δ rays escape (lower *dE/dx*)

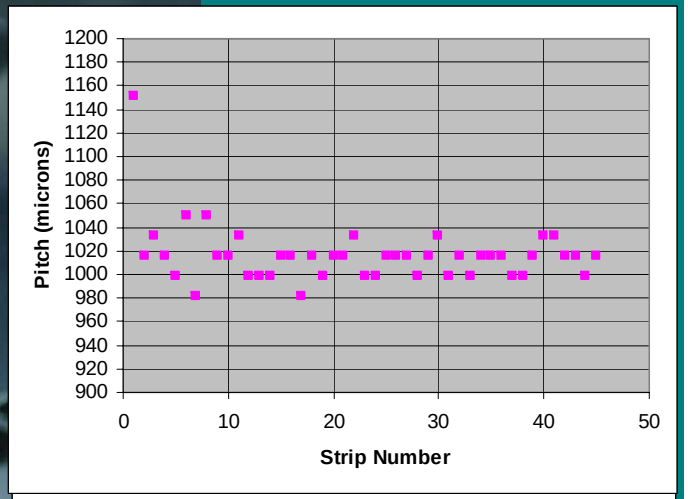
First SEM Delivery

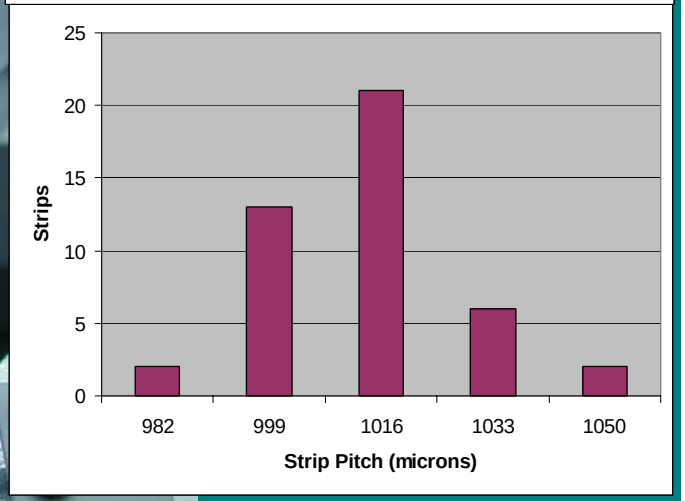
- Recall cables on this paddle are different from future models
- Signal lines routed through shaft
- We changed partially to reduce vacuum gas load (this now suspect)
- We will maintain full ‘swapability’



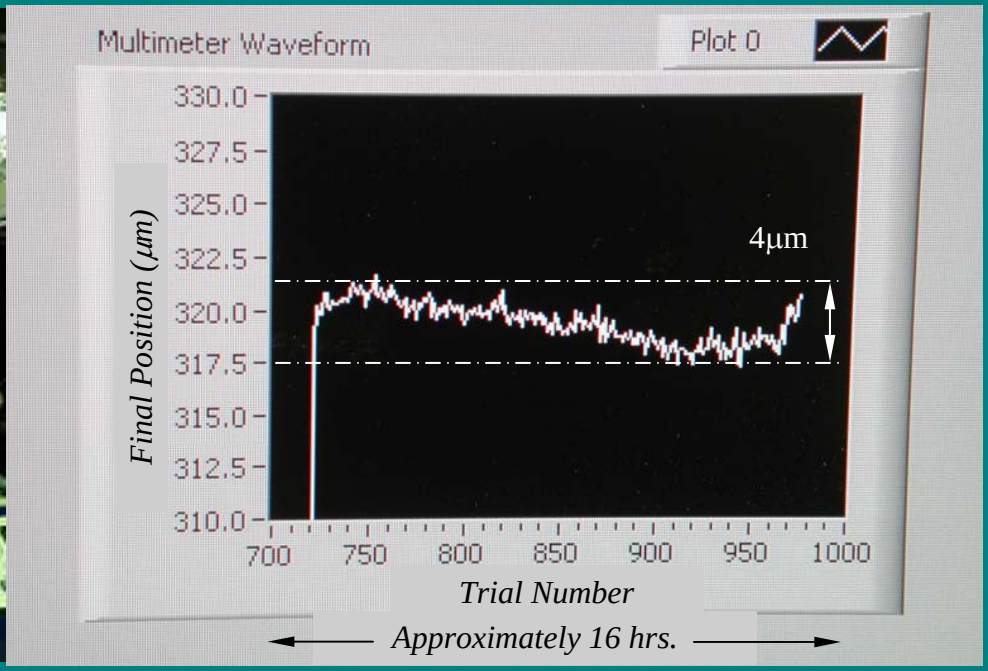
Foil Etching







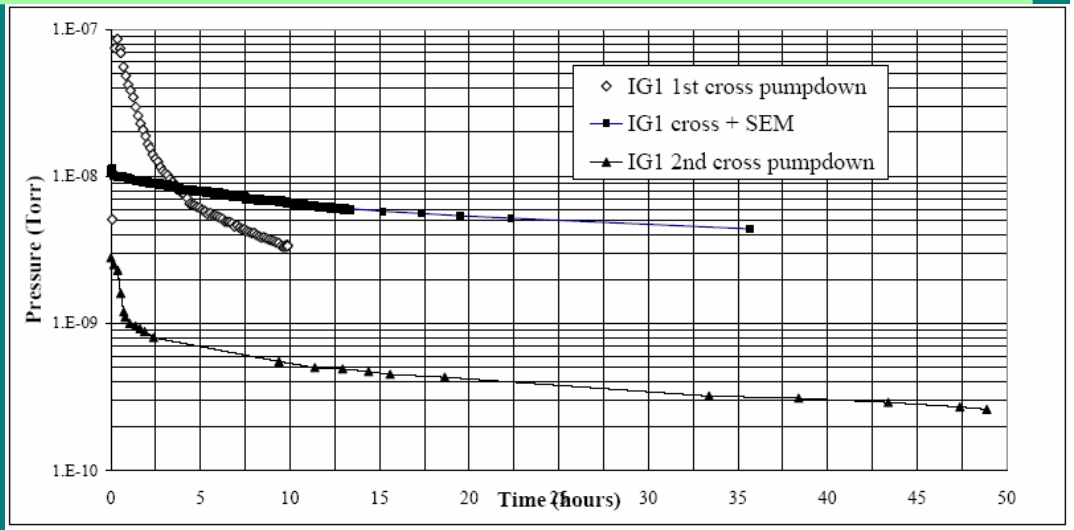
Foil Insertion Actuator Tests

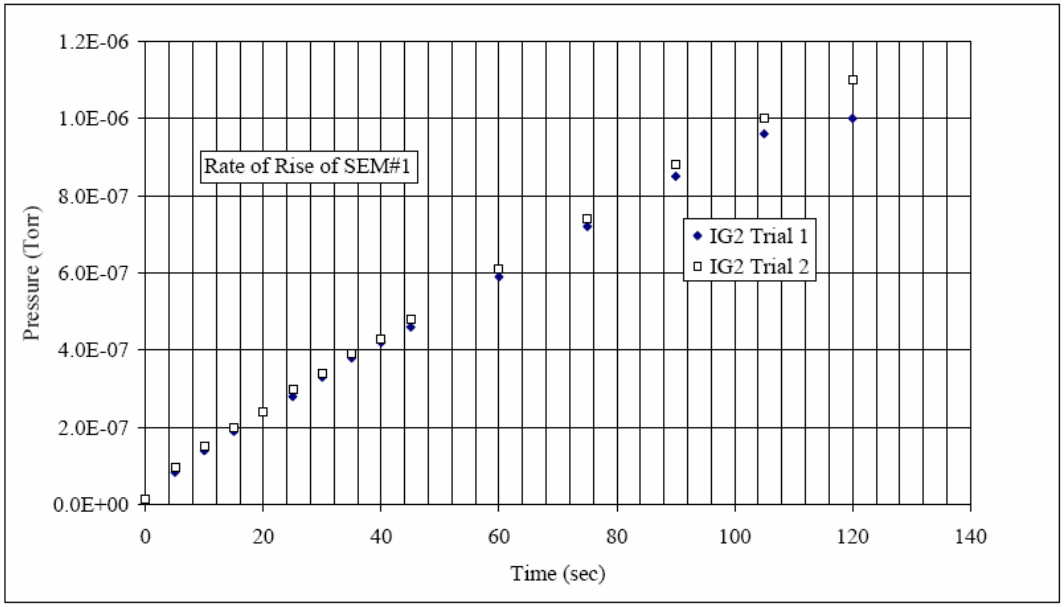


- Tested with chamber evacuated to 1E-8 Torr on turbo pump
- Similar short-term ~1μm accuracy as observed last fall on bench test
- Slightly worse performance if no vacuum (5–10 μm) so vacuum helps slow motor
- Long-term study would be helpful once we get FNAL controller driving this.

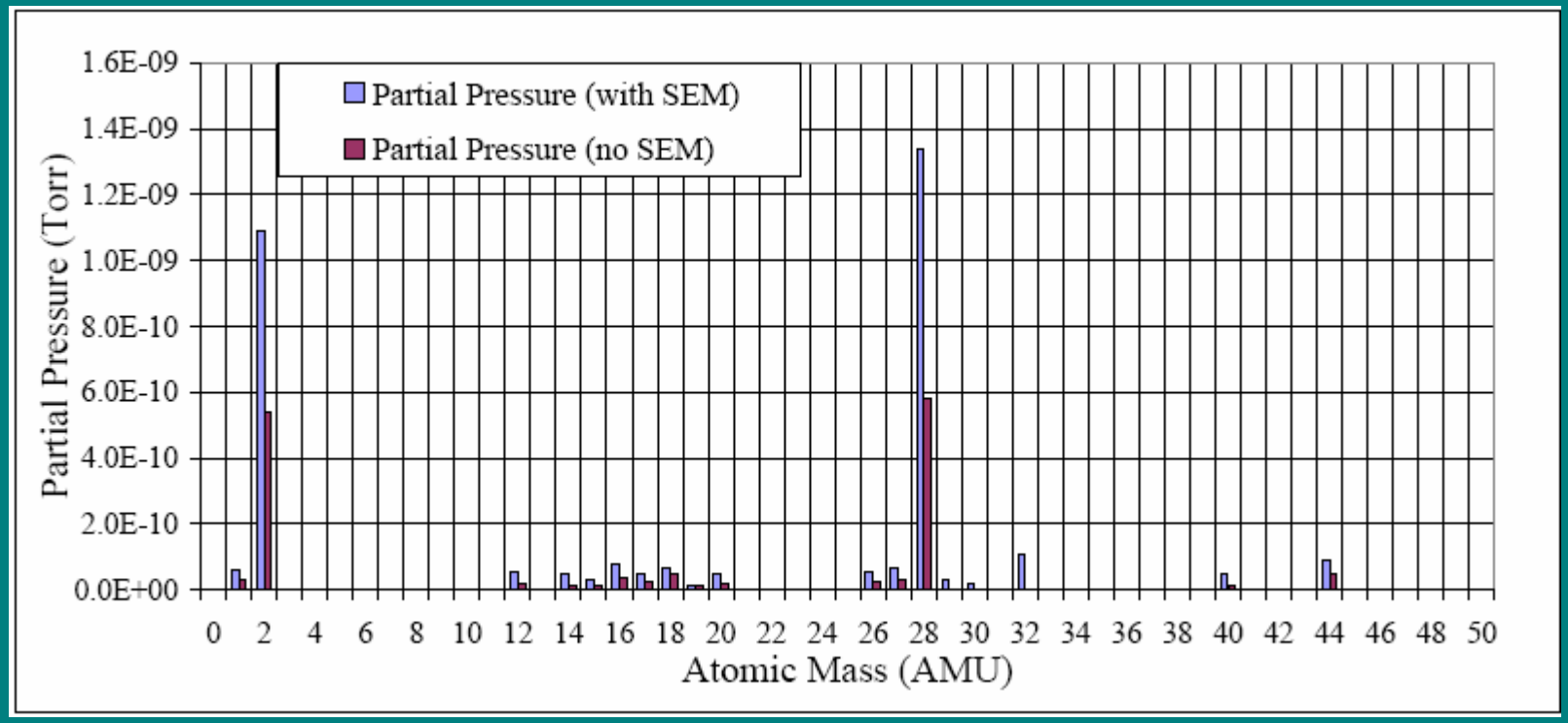
Vacuum Tests of SEM#1

- Rate of pressure rise is 9E-9Torr/sec
- Volume is ~ 14.9 liters
- Infer outgas rate 1.3E-7 Torr-liter/sec (could be O-rings?)
- Ultimate pressure on ion pump ~4E-9Torr
- Infer pump speed at chamber is 35 liter/sec (consistent with 50l/sec pump and the conductance of cross, gate valves, *etc*)



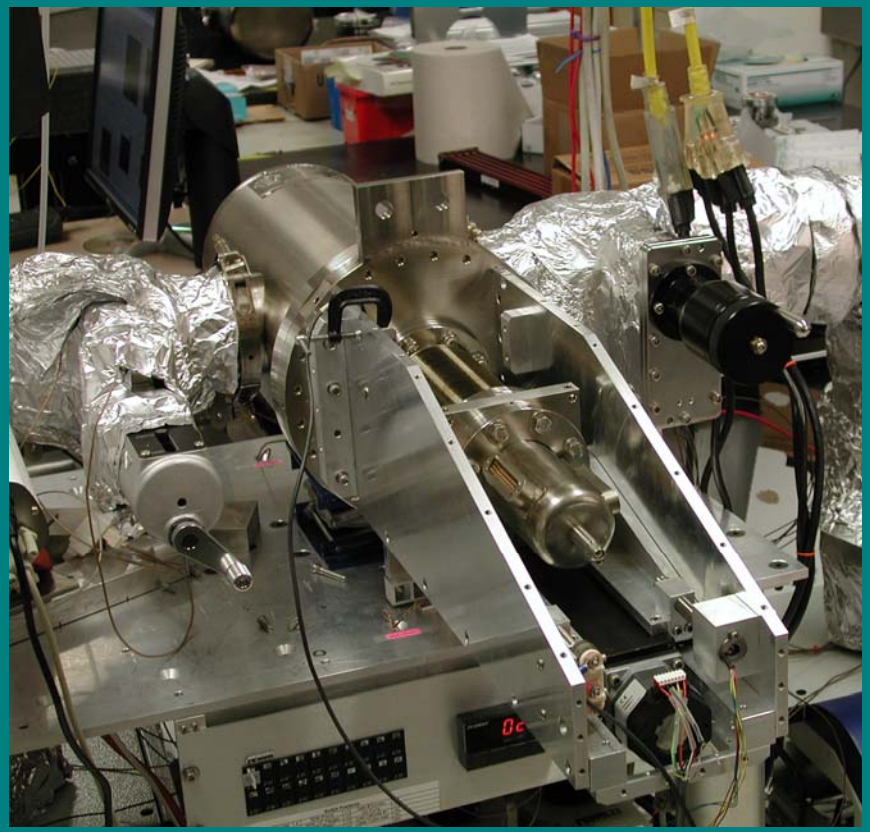


Vacuum Tests (*cont'd*)



- RGA test performed with SEM gated in/out of system
- Largely similar contaminants as obtained last fall.
- Evidently a very small leak (virtual??) exists – O-rings?.

What's *Not* Completed on SEM #1



- Brackets not anodized
- No plexiglass moisture cover
- Plexiglass cover also will have feedthroughs for
  - »LVDT
  - »Motor
  - »Switches
  - »Signal lines
  - »HV
- When we bring this cover up, will bring cables to go from vacuum feedthrough to plexiglass feedthrough.

What Needs to be Done at FNAL

- Cary K. to disassemble 10” CF flange seal
- Survey / alignment of foils
  - »Optical!
  - »With respect to dowel holes on 10”CF, moving shaft
- Re-bake of SEM for vacuum
  - »Requires removing actuator
  - »Requires jig (supplied) to stabilize bellows during bake
- Re-assembly of actuator
  - »We would like to do this (lots of concern over alignment of bellows, which affects fatigue lifetime)
  - »We will supply plexiglass cover at this time

Production

- All vacuum chamber parts complete
- Now cleaning all parts
  - »So far 6/12 cans clean
  - »Paddles+shafts all through "1st pass" clean (soapy water)
  - »Yet to commence
    - 10" CF lids
    - small accessories

Production (*cont'd*)

- New kapton ribbon cables have arrived
  - »Checked one in vacuum chamber – no problems
  - »Tested flexing using actuator + paddle mounted on 10"CF

Production (*cont'd*)

- Will assemble all 1mm pitch paddles simultaneously
  - »Commence next week – total time ~ 3wks
  - »Implies next bakeout *not* before May 8
- Actuators
  - »Require some revision based on 1st SEM
  - »Re-design commences May 8
  - »Require 4wks to machine all parts
- 0.5 mm pre-target SEM's
  - »Ceramic designed
  - »Paddle frame still tweaking
  - »Foil tests seem slow at vendor (limited by our 1mm jobs?)